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Biosafety familiarity, attitudes, and practice readiness in Philippine veterinary education

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ABSTRACT

Biosafety instruction in veterinary education must prepare learners to manage zoonotic pathogens, animal-derived specimens, sharps, contaminated environments, and laboratory hazards, yet Philippine multi-school evidence on biosafety familiarity, attitudes, and practice/readiness remains limited. This cross-sectional study assessed self-reported biosafety familiarity, attitudes, and practice/readiness among 255 respondents from 21 selected veterinary schools in the Philippines, comprising 236 undergraduate Doctor of Veterinary Medicine students and 19 faculty/educators. Scale-based theoretical terciles showed high familiarity in 95.29% and high attitude in 88.24% of respondents, whereas high practice/readiness was lower at 64.31%. Practice/readiness also had the lowest domain mean score (3.87±0.57) compared with familiarity (4.55±0.45) and attitude (4.17±0.42). Weaker item-level areas included hazardous-material handling skills, spill or exposure preparedness, and institutional resource adequacy. Welch comparisons showed higher domain scores among faculty/educators than students, but interpretation was cautious because of the small educator subgroup. Student-only HC3 robust regression showed that familiarity was associated with attitude ($p<0.001$), while familiarity ($p=0.001$) and attitude ($p<0.001$) were associated with practice/readiness. Findings support competency-based biosafety training, supervised drills, adequate resources, and institutional biosafety audits.

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1. INTRODUCTION

Biosafety is an essential component of veterinary education because it reduces exposure to infectious agents, animal-derived specimens, sharps, aerosols, contaminated surfaces, and other biological hazards. Veterinary students and educators work across teaching laboratories, clinics, farms, animal-handling areas, necropsy facilities, and diagnostic settings where zoonotic and occupational risks may occur [1]–[3]. Global biosafety guidance emphasizes risk assessment, standard microbiological practices, appropriate containment, personal protective equipment (PPE), decontamination, waste management, and institutional biosafety programs as basic requirements for biological work [1]–[3]. These requirements are particularly

important in veterinary training because students may handle animals, biological materials, and contaminated environments before they have fully developed procedural confidence and safety habits [4], [5]. Knowledge, attitudes, and practices (KAP) are related but distinct constructs in biosafety education. In this study, knowledge/familiarity refers to self-reported cognitive awareness of biosafety concepts and procedures, attitude refers to beliefs and perceived importance, and practice/readiness refers to reported behavior, perceived capability, preparedness, and implementation support. A KAP gap is expected in veterinary settings because safe biosafety performance depends not only on familiarity but also on procedural skill, repeated supervised practice, accessible resources, faculty modeling, institutional enforcement, and safety culture [4], [6]. Behavioral theory also supports this distinction because awareness and favorable beliefs may influence reported safety behavior, but they do not guarantee consistent implementation when resources, perceived control, and workplace norms are weak [7].

Teaching laboratories require additional attention because students are still acquiring technical competence and may not yet have fully internalized safe work habits. Teaching-laboratory biosafety guidance emphasizes instructor competency, student supervision, PPE, waste management, routine disinfection, and clear local procedures for biosafety level 1 and biosafety level 2 settings [6]. In veterinary programs, these requirements extend beyond laboratory benches because students may encounter live animals, biological samples, clinical waste, farm environments, and diagnostic specimens that require consistent biosafety decisions [3], [5]. Philippine Doctor of Veterinary Medicine training also includes laboratory, clinical, animal health, public health, and professional competencies that require the safe handling of biological materials and potentially infectious specimens [8].

Evidence from Philippine college students suggests moderate to high biosafety-related knowledge in health-related programs, particularly for hand hygiene, PPE, infection control, and standard precautions [9]–[12]. However, several studies also show weaker performance in specialized procedural areas, including disease-transmission routes, needlestick injury prevention, laboratory safety symbols, and technical biosafety practices [9], [10], [13]. Knowledge-practice disconnects have been reported in Philippine nursing, medical laboratory science, and other student groups, indicating that awareness alone is insufficient for reliable biosafety compliance [10]–[12]. Institutional differences in biosafety practice and national biorisk assessments further suggest that resources, training systems, laboratory infrastructure, and policy implementation may shape student readiness [13], [14].

Despite these related findings, biosafety evidence specific to Philippine veterinary education remains limited. Veterinary biosafety cannot be inferred fully from general health-student studies because veterinary students and educators face animal-associated risks, zoonotic pathogens, necropsy exposure, farm biosecurity concerns, and diagnostic-material hazards that differ from many human-health teaching contexts [3]–[5]. Biosecurity and antimicrobial stewardship were not measured directly, but they provide relevant curricular context because containment, infection prevention, animal health protection, and responsible biological-risk management overlap with biosafety competencies [3], [8]. Philippine veterinary and laboratory evidence also points to sparse biosafety documentation, gaps in safety knowledge and practice, occupational hazards, infrastructure limitations, and incomplete implementation of biorisk governance systems [14]–[16].

The scientific question addressed was whether veterinary students and educators from selected Philippine veterinary schools report similar levels of biosafety familiarity, attitudes, and practice/readiness, and whether familiarity and attitudes are associated with practice/readiness among students. The present study assessed respondent profiles, item-level KAP patterns, scale-based domain-level KAP levels, and statistical factors associated with biosafety familiarity, attitudes, and practice/readiness. The conceptual framework treats respondent and contextual factors as possible influences on biosafety familiarity, attitudes, and practice/readiness, while recognizing a sequential familiarity-attitude-practice/readiness pathway consistent with KAP logic and behavioral theory, as shown in Figure 1 [4], [7].

The novelty of this study lies in its multi-school examination of biosafety familiarity, attitudes, and practice/readiness in Philippine veterinary education, a context that remains underrepresented in biosafety education research. It identifies an implementation gap between high self-reported familiarity and favorable attitudes and weaker practice/readiness. It examines relationships among the domains using student-specific HC3 robust regression and sensitivity analyses. These findings provide context-specific evidence for combining competency-based instruction, supervised practical training, and institutional biosafety support.

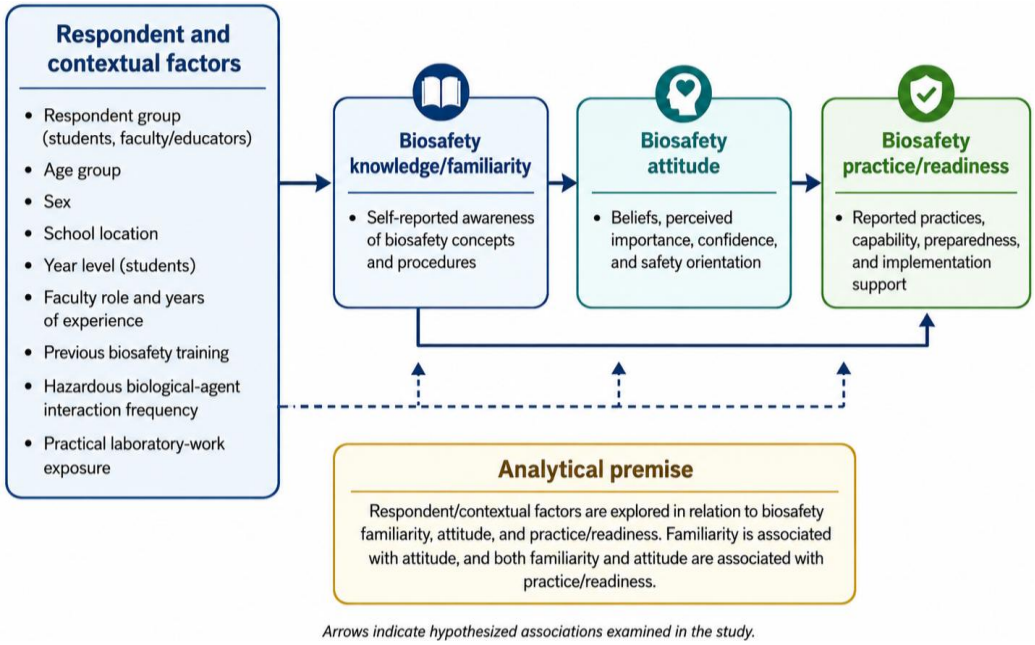


Figure 1. Conceptual framework of the study

2. METHOD

2.1. Research design and study setting

This study used a descriptive cross-sectional survey design to assess biosafety-related familiarity, attitudes, and practice/readiness among veterinary students and educators. Data were collected through an online Google Forms questionnaire from November 5, 2024 to January 21, 2025. Respondents were recruited from selected veterinary schools in the Philippines. The reporting structure was checked against the strengthening the reporting of observational studies in epidemiology (STROBE) guidance for observational studies [17].

2.2. Respondents, recruitment, and sampling

The analytic dataset included 255 valid respondents, composed of 236 undergraduate Doctor of Veterinary Medicine students and 19 faculty/educators. Eligible student respondents were undergraduate veterinary students enrolled in participating veterinary schools during the data-collection period. Eligible faculty respondents were veterinary educators affiliated with participating schools. Respondents were recruited through purposive and convenience sampling with assistance from institutional contacts, faculty coordinators, and school representatives who circulated the online survey link to eligible participants.

The sample size was determined by the number of eligible and consenting respondents who completed the online questionnaire during the data-collection period, consistent with the purposive and convenience recruitment strategy used in this exploratory multi-school survey. Because a complete national sampling frame of eligible veterinary students and educators was not available, the sample was not calculated to produce nationally representative prevalence estimates. Analytic adequacy was instead assessed for the most parameter-heavy student-only regression model, which included seven predictors: sex, school location, year level, hazardous biological-agent interaction frequency, practical laboratory exposure, knowledge/familiarity score, and attitude score. Using Green's regression sample-size guidance, the minimum sample size would be 106 for testing the overall multiple correlation using $N \geq 50+8m$ and 111 for testing individual predictors using $N \geq 104+m$, where m is the number of predictors [18]. The complete-case student regression sample of 233 exceeded both minimums; therefore, the achieved sample was considered adequate for the planned exploratory regression analyses, while generalizability remained limited by nonprobability sampling.

Respondents were drawn from 21 schools: Aklan State University, Benguet State University, Bulacan Agricultural State College, Cagayan State University, Capiz State University, Cavite State University, Central Bicol State University of Agriculture, Central Luzon State University, Central Mindanao University, De La Salle Araneta University, Don Mariano Marcos Memorial State University, Isabela State University, Nueva Vizcaya State University, Pampanga State Agricultural University, Southwestern University-PHINMA, Tarlac Agricultural University, University of Eastern Philippines, University of Southern Mindanao, University of the Philippines Los Baños, Virgen Milagrosa University Foundation, and

Visayas State University. Participation was uneven across institutions and regions. Most respondents were from Luzon-based schools, and the three highest-contributing schools collectively contributed more than half of the total sample.

Because the study used nonprobability sampling, the findings should be interpreted as exploratory and not representative of all veterinary schools in the Philippines. Schools with stronger biosafety awareness, more responsive administrators, active student networks, or more engaged faculty coordinators may have been more likely to circulate the survey or encourage participation. Students and educators with a greater interest in biosafety may also have been more likely to respond. These recruitment and participation patterns may have led to more favorable KAP estimates but limited generalizability.

2.3. Research instrument and construct measurement

The questionnaire items were initially constructed from established biosafety literature, existing survey materials, and biological-risk management guidance relevant to laboratory and veterinary settings, including biosafety materials from the University of Texas Rio Grande Valley and WOAH guidance on managing biological risk in veterinary laboratories and animal facilities [3], [19]. The instrument contained demographic questions and three KAP domains: knowledge/familiarity, attitude, and practice/readiness. The knowledge/familiarity domain had 9 items, the attitude domain had 20 items, and the practice/readiness domain had 16 items.

Before full administration, the questionnaire underwent face and content validation by three veterinary experts. The experts evaluated item relevance, clarity, appropriateness, and alignment with the intended biosafety domains and veterinary education context. Expert assessment yielded a content validity index (CVI) of 1.00, providing evidence supporting content relevance and item appropriateness. This expert-validation process supported content validity but did not independently establish structural or dimensional construct validity.

The knowledge/familiarity items used familiarity-based response options rather than objectively scored correct or incorrect responses. Hence, this domain is interpreted as self-reported biosafety familiarity rather than direct evidence of objective knowledge or demonstrated procedural competence. Several items were based on basic laboratory biosafety practices, such as handwashing, sharps management, decontamination, signage, transport of contaminated materials, pest management, and surface disinfection. This item set does not fully represent all veterinary biosafety competencies, including animal restraint, zoonotic transmission routes, necropsy procedures, farm and field biosecurity, clinical waste segregation, and observed compliance.

The attitude domain included items on perceived importance, beliefs, safety culture, confidence, and self-efficacy. Item A03, which framed biosafety protocols as possible barriers to work efficiency, was negatively keyed and reverse-coded for the adjusted attitude score so that higher values consistently indicated more favorable biosafety attitudes. Descriptive item-level results for A03 were also examined in the original direction because agreement with this item represents a potential attitudinal barrier to compliance. Confidence and self-efficacy items were retained within the broad attitude domain, but these constructs are theoretically distinct from attitude in behavioral frameworks that separate attitude from perceived behavioral control or efficacy beliefs [7].

The practice/readiness domain included items on reported behavior, feasibility, perceived capability, preparedness, and institutional resource adequacy. Because several items reflect readiness, confidence, or resource availability rather than directly observed behavior, the domain is interpreted as self-reported practice/readiness rather than observed biosafety compliance. The operational domain definitions were retained to preserve alignment with the study's intended KAP framework, while recognizing that some item content overlapped with theoretically distinct constructs. Exploratory and confirmatory factor analyses were not conducted; therefore, the three-domain configuration should not be interpreted as a fully established latent psychometric structure [20].

Following expert validation, a pilot test was conducted among 21 initial respondents who were excluded from the analytic dataset. Pilot testing assessed questionnaire clarity, online completion, item flow, and response capture before final data collection. The final analytic dataset was assessed for internal consistency using Cronbach's alpha. Cronbach's alpha values were 0.877 for knowledge/familiarity, 0.844 for the A03-adjusted attitude scale, and 0.905 for practice/readiness, indicating acceptable to excellent internal consistency. These coefficients were interpreted as evidence of score reliability and not as independent evidence of structural or dimensional construct validity [21].

2.4. Scoring and categorization

All KAP items were scored on a 1 to 5 scale, with higher scores indicating greater familiarity with biosafety, more favorable biosafety attitudes, or better self-reported practice/readiness. Domain scores were

calculated as the mean of the items in each domain. The attitude domain used the A03 reverse-coded adjusted score for scale-level analysis, while the original A03 response pattern was retained for item-level interpretation.

KAP scores were categorized descriptively using scale-based theoretical terciles within the possible 1.00 to 5.00 score range: low=1.00 to 2.33, moderate=>2.33 to 3.67, and high=>3.67 to 5.00. These categories were used for descriptive interpretation only, while inferential analyses used continuous domain scores. A score above 3.67 indicates placement in the upper third of the possible score range and should not be interpreted as evidence of consistently excellent or directly observed compliance. Potential ceiling effects were considered because high response rates at the upper end of the scale can reduce discrimination among respondents [22].

2.5. Data processing and statistical analysis

Raw Google Forms responses were cleaned by removing blank rows, standardizing spelling and capitalization of response options, parsing text ages into numeric age values, and verifying school-location categories. School locations were grouped into Luzon and Visayas-Mindanao to reduce the number of sparse institutional categories. A separate Mindanao-only analysis was not used because several schools had small cell counts, and the available sample was not adequate for stable three-region modeling.

Descriptive statistics were reported as frequencies and percentages for categorical variables and as means, standard deviations (SD), medians, and interquartile ranges for continuous variables. Item-level descriptive KAP levels were summarized in the main manuscript using low, moderate, and high categories for each item. The complete response-option distribution for each item was retained. Floor and ceiling patterns were reviewed descriptively by examining the proportion of respondents with maximum domain scores and scores of at least 4.50.

Between-group comparisons of student and faculty/educator KAP mean scores were performed using Welch's t-test because the two groups were unequal in size. These comparisons were treated as exploratory because the faculty/educator subgroup was small and differed from students in age, professional role, teaching experience, and expected biosafety exposure. Spearman correlation was used for ordinal predictors in bivariate analysis, and Benjamini-Hochberg false discovery rate adjustment was applied to related bivariate tests.

Adjusted regression models were limited to students because the faculty/educator subgroup was too small for stable multivariable modeling. Ordinary least squares regression with HC3 robust standard errors (SE) was used to estimate associations with knowledge/familiarity, attitude, and practice/readiness scores. HC3 was selected because heteroskedasticity-consistent estimators with improved finite-sample properties provide more conservative inference when residual variance or leverage may affect ordinary least squares SE [23].

Student regression models included sex, school location, year level, hazardous biological-agent interaction frequency, and practical laboratory exposure. Hazardous biological-agent interaction frequency referred to how often respondents reported interacting with potentially hazardous biological agents or materials during educational activities, while practical laboratory exposure referred to the extent of hands-on laboratory work experience. The attitude model additionally included knowledge/familiarity, while the practice/readiness model included knowledge/familiarity and attitude. Three students who selected "prefer not to say" for sex were excluded from sex-adjusted regression models, resulting in n=233 for adjusted analyses.

Two supplementary sensitivity analyses were conducted. To address construct overlap in the practice/readiness scale, reduced behavioral/implementation practice scores were computed for P01-P05 and P13-P16. It was used as an alternative outcome in a student-only HC3 robust regression model. This analysis remained supplementary because P13 and P14 were the only true behavioral frequency items, while P01 to P05 and P15 to P16 primarily reflected feasibility, implementation support, preparedness, or corrective readiness rather than direct behavior. To address institutional concentration, student-only regression models were repeated after excluding the three largest contributing schools: Benguet State University, Cavite State University, and Don Mariano Marcos Memorial State University.

2.6. Ethical considerations

The study was approved by the Cebu Technological University-Daan Bantayan Local Research Ethics Committee (LREC) on February 15, 2025, with approval code CTU-DB 25-013. All respondents provided informed consent electronically before answering the questionnaire. Participation was voluntary, and responses were handled confidentially for research purposes.

3. RESULTS AND DISCUSSION

3.1. Respondent profile

The study included 255 respondents, consisting of 236 undergraduate veterinary students (92.55%) and 19 faculty/educators (7.45%). The largest age group was 21 to 25 years (146/255, 57.25%), followed by

respondents aged 20 years or younger (76/255, 29.80%). The total sample was predominantly female (166/255, 65.10%), and most respondents were from Luzon schools (200/255, 78.43%). Institutional participation was concentrated, with the three highest-contributing schools accounting for 140 respondents (54.90%). Student respondents were distributed across the six-year levels of the Doctor of Veterinary Medicine program, while faculty/educator respondents represented lecturer/instructor, assistant professor, associate professor, and professor roles, as shown in Table 1.

Table 1. Profile of students and faculty respondents (n=255)

Parameter	Category/statistic	Students (n=236)	Faculty/educators (n=19)	Total (n=255)
Age group	≤20 years	76 (32.20)	0 (0.00)	76 (29.80)
	21 to 25 years	145 (61.44)	1 (5.26)	146 (57.25)
	26 to 30 years	13 (5.51)	2 (10.53)	15 (5.88)
	31 to 40 years	2 (0.85)	10 (52.63)	12 (4.71)
	>40 years	0 (0.00)	6 (31.58)	6 (2.35)
Sex	Female	156 (66.10)	10 (52.63)	166 (65.10)
	Male	77 (32.63)	9 (47.37)	86 (33.73)
	Prefer not to say	3 (1.27)	0 (0.00)	3 (1.18)
School location	Luzon	186 (78.81)	14 (73.68)	200 (78.43)
	Visayas-Mindanao	50 (21.19)	5 (26.32)	55 (21.57)
Institutional representation	Three highest-contributing schools combined	133 (56.36)	7 (36.84)	140 (54.90)
	Other participating schools combined	103 (43.64)	12 (63.16)	115 (45.10)
Year level in DVM program (for students)	First-year	29 (12.29)	Not applicable	29 (11.37)
	Second-year	40 (16.95)		40 (15.69)
	Third-year	46 (19.49)		46 (18.04)
	Fourth-year	40 (16.95)		40 (15.69)
	Fifth-year	42 (17.80)		42 (16.47)
	Sixth-year	39 (16.53)		39 (15.29)
Faculty position/role	Assistant professor	Not applicable	8 (42.11)	8 (3.14)
	Lecturer/instructor		6 (31.58)	6 (2.35)
	Associate professor		4 (21.05)	4 (1.57)
	Professor		1 (5.26)	1 (0.39)
Years of experience	1 to 3 years	Not applicable	6 (31.58)	6 (2.35)
	4 to 6 years		7 (36.84)	7 (2.75)
	7 to 10 years		3 (15.79)	3 (1.18)
	More than 10 years		3 (15.79)	3 (1.18)
Previous biosafety training	Yes	--	9 (47.37)	9 (3.53)
	No or not indicated	--	10 (52.63)	10 (3.92)
Hazardous biological-agent interaction frequency	Never	11 (4.66)	1 (5.26)	12 (4.71)
	Rarely	81 (34.32)	5 (26.32)	86 (33.73)
	Occasionally	113 (47.88)	9 (47.37)	122 (47.84)
	Frequently	31 (13.14)	4 (21.05)	35 (13.73)
Practical laboratory work exposure	Never	7 (2.97)	0 (0.00)	7 (2.75)
	Occasionally	116 (49.15)	9 (47.37)	125 (49.02)
	Frequently	85 (36.02)	8 (42.11)	93 (36.47)
	Always	28 (11.86)	2 (10.53)	30 (11.76)

Note: values are n (%) unless otherwise indicated. Percentages for student and faculty/educator columns were computed within each respondent group, while total percentages were computed from the full sample. Not applicable indicates variables specific to either students or faculty/educators. Individual school names are listed in the method section; institutional representation was summarized in grouped form to reduce table length. The sample was nonprobability-based and should be interpreted as descriptive and exploratory.

3.2. Item-level response patterns

Item-level descriptive results showed consistently high knowledge/familiarity scores across all nine items. High-level responses were lowest for integrated pest management (222/255, 87.06%) and highest for handwashing after hazardous-material work and safe sharps management (253/255, 99.22% each). These patterns indicate strong self-reported familiarity with basic laboratory biosafety procedures, especially hand hygiene and sharps safety, but relatively weaker familiarity with institutional pest-management systems, as seen in Table 2 (see Appendix).

Most attitude, belief, and confidence items were classified as high, but several confidence-related items showed more moderate response distributions. The reverse-coded workflow-barrier item was classified as moderate, and its original response direction showed that 128 respondents (50.20%) agreed or strongly agreed that biosafety protocols sometimes interfere with veterinary work efficiency. This result identifies perceived workflow burden as a possible barrier that may coexist with otherwise favorable biosafety attitudes.

Practice/readiness showed the most variable item-level pattern among the three KAP domains. High-level responses were strongest for appropriate PPE use when interacting with potentially hazardous

animals (222/255, 87.06%), decontamination after handling biological materials (219/255, 85.88%), and PPE use in laboratory or clinical settings (200/255, 78.43%). Weaker areas were observed for skills in safely handling potentially hazardous biological materials (109/255, 42.75%), preparedness to respond to spills or accidental exposure (132/255, 51.76%), confidence in applying biosafety levels and precautions (127/255, 49.80%), and institutional provision of PPE, disinfectants, and other biosafety resources (148/255, 58.04%). These item-level results indicate that practical capability, emergency preparedness, and institutional resource adequacy were weaker than general familiarity and favorable safety beliefs.

3.3. Knowledge, attitudes, and practices levels

Using scale-based theoretical tercile cutoffs, most respondents were classified as high on knowledge/familiarity and attitude. High knowledge/familiarity was observed among 224 students (94.92%) and all 19 faculty/educators (100.00%), while high attitude was observed among 207 students (87.71%) and 18 faculty/educators (94.74%). These high classifications represent upper-range self-reported scores and should not be interpreted as objective evidence of advanced procedural competence, as shown in Table 3.

Practice/readiness was the weakest KAP domain. High practice/readiness was observed among 149 students (63.14%) and 15 faculty/educators (78.95%), giving an overall high classification of 164 respondents (64.31%). The total mean practice/readiness score (3.87±0.57) was lower than the total knowledge/familiarity score (4.55±0.45) and the total attitude score (4.17±0.42). This pattern indicates that self-reported implementation readiness was less consistent than familiarity and attitudes, particularly among students, as shown in Table 3.

Ceiling patterns were most evident for knowledge/familiarity. Maximum domain scores were observed in 62 respondents (24.31%) for knowledge/familiarity, 1 respondent (0.39%) for attitude, and 6 respondents (2.35%) for practice/readiness. Scores of at least 4.50 were observed in 164 respondents (64.31%) for knowledge/familiarity, 67 respondents (26.27%) for attitude, and 39 respondents (15.29%) for practice/readiness. These patterns suggest greater score compression in the knowledge/familiarity domain than in the attitude and practice/readiness domains.

Table 3. KAP levels of students and faculty respondents using scale-based theoretical tercile cutoffs

Group	KAP domain	Mean±SD	Median	Low n (%)	Moderate n (%)	High n (%)
Students	Knowledge/familiarity	4.53±0.46	4.67	0 (0.00)	12 (5.08)	224 (94.92)
	Attitude	4.15±0.41	4.20	0 (0.00)	29 (12.29)	207 (87.71)
	Practice/readiness	3.85±0.57	3.88	2 (0.85)	85 (36.02)	149 (63.14)
Faculty/educators	Knowledge/familiarity	4.77±0.26	4.89	0 (0.00)	0 (0.00)	19 (100.00)
	Attitude	4.43±0.38	4.50	0 (0.00)	1 (5.26)	18 (94.74)
	Practice/readiness	4.18±0.54	4.25	0 (0.00)	4 (21.05)	15 (78.95)
Total	Knowledge/familiarity	4.55±0.45	4.67	0 (0.00)	12 (4.71)	243 (95.29)
	Attitude	4.17±0.42	4.25	0 (0.00)	30 (11.76)	225 (88.24)
	Practice/readiness	3.87±0.57	3.88	2 (0.78)	89 (34.90)	164 (64.31)

Note: low=1.00 to 2.33, moderate=>2.33 to 3.67, and high=>3.67 to 5.00. Categories are descriptive only; inferential analyses used continuous domain scores. A score above 3.67 indicates placement in the upper third of the possible scale range and should not be interpreted as direct evidence of consistently excellent or observed compliance. Attitude uses the A03 reverse-coded adjusted score.

3.4. Statistical analysis results

Welch's t-tests showed that faculty/educators had higher mean KAP scores than students. These differences remained significant after false discovery rate adjustment for knowledge/familiarity ($p=0.002$, $q=0.010$), attitude ($p=0.006$, $q=0.022$), and practice/readiness ($p=0.017$, $q=0.044$). These comparisons were interpreted cautiously because the faculty/educator subgroup was small and differed from students in age, role, teaching experience, professional responsibility, and expected biosafety exposure, as shown in Table 4.

In the adjusted student-only HC3 robust regression models, the knowledge/familiarity model had modest explanatory power (adjusted $R^2=0.065$, $p=0.002$). Female sex was positively associated with knowledge/familiarity ($B=0.131$, $p=0.040$), and year level was also positively associated with knowledge/familiarity ($B=0.049$, $p=0.015$). The small coefficient for year level indicates limited practical magnitude on the 1 to 5 scale, while the low adjusted R^2 indicates that the model explained only a small proportion of variation in biosafety familiarity, as shown in Table 4.

The attitude model showed stronger explanatory power than the knowledge/familiarity model (adjusted $R^2=0.302$, $p<0.001$). Knowledge/familiarity was positively associated with attitude ($B=0.429$, $p<0.001$), while year level showed a smaller positive association ($B=0.032$, $p=0.042$). The practice/readiness model had the highest explanatory power among the three models (adjusted $R^2=0.434$, $p<0.001$). Knowledge/familiarity ($B=0.279$, $p=0.001$) and attitude ($B=0.714$, $p<0.001$) were both positively associated with practice/readiness, but these cross-sectional associations should not be interpreted as causal effects.

The reduced behavioral/implementation practice sensitivity analysis showed acceptable internal consistency (Cronbach's alpha=0.800), a mean score of 4.04±0.55, and a strong correlation with the full practice/readiness score (r=0.910). In the student-only robust regression model, knowledge/familiarity (B=0.239, p=0.004) and attitude (B=0.679, p<0.001) remained positively associated with the reduced practice score. This finding supported the direction of the main model, although the reduced score still included readiness and implementation-support items rather than purely observed behaviors.

The school-concentration sensitivity analysis retained 101 complete-case student respondents after excluding Benguet State University, Cavite State University, and Don Mariano Marcos Memorial State University. In this reduced dataset, knowledge/familiarity remained positively associated with attitude (B=0.492, p<0.001). Knowledge/familiarity (B=0.438, p=0.007) and attitude (B=0.667, p<0.001) also remained positively associated with practice/readiness. Associations between sex and year level, and between knowledge/familiarity and the familiarity-attitude-practice/readiness pattern, were attenuated, suggesting that demographic associations were less stable than the familiarity-attitude-practice/readiness pattern.

Table 4. Robust linear regression models for factors associated with biosafety KAP scores among veterinary students (n=233)

Domain	Adjusted R^2	Predictor	B	Robust SE	95% CI	p-value	VIF
Knowledge/ familiarity	0.065	Female (vs male)	0.131	0.064	0.006 to 0.257	0.040	1.01
	0.065	Visayas-Mindanao school (vs Luzon)	-0.105	0.082	-0.267 to 0.056	0.202	1.01
	0.065	Year level	0.049	0.020	0.009 to 0.089	0.015	1.11
	0.065	Biological-agent interaction frequency	0.002	0.048	-0.091 to 0.096	0.960	1.32
	0.065	Practical laboratory exposure	0.069	0.044	-0.018 to 0.156	0.118	1.28
Attitude	0.302	Female (vs male)	0.051	0.054	-0.055 to 0.157	0.348	1.03
	0.302	Visayas-Mindanao school (vs Luzon)	-0.119	0.063	-0.243 to 0.006	0.061	1.02
	0.302	Year level	0.032	0.016	0.001 to 0.063	0.042	1.15
	0.302	Biological-agent interaction frequency	0.009	0.036	-0.061 to 0.080	0.793	1.32
	0.302	Practical laboratory exposure	0.021	0.029	-0.036 to 0.077	0.479	1.30
	0.302	Knowledge/familiarity score	0.429	0.062	0.306 to 0.551	<0.001	1.09
Practice/ readiness	0.434	Female (vs male)	0.000	0.062	-0.121 to 0.122	0.998	1.04
	0.434	Visayas-Mindanao school (vs Luzon)	-0.041	0.072	-0.183 to 0.101	0.570	1.04
	0.434	Year level	-0.040	0.021	-0.081 to 0.002	0.060	1.17
	0.434	Biological-agent interaction frequency	0.028	0.047	-0.063 to 0.120	0.545	1.32
	0.434	Practical laboratory exposure	0.044	0.041	-0.035 to 0.124	0.277	1.30
	0.434	Knowledge/familiarity score	0.279	0.085	0.112 to 0.447	0.001	1.43
	0.434	Attitude score	0.714	0.094	0.530 to 0.899	<0.001	1.47

Note: B=unstandardized regression coefficient; CI=confidence interval; VIF=variance inflation factor. Robust linear regression used HC3 SE. Model fit: knowledge/familiarity R^2=0.085, adjusted R^2=0.065, p=0.002; attitude R^2=0.320, adjusted R^2=0.302, p<0.001; practice/readiness R^2=0.451, adjusted R^2=0.434, p<0.001. Three students who selected "Prefer not to say" for sex were excluded from sex-adjusted regression models.

3.5. Discussion

High self-reported biosafety familiarity and favorable attitudes were observed among veterinary students and educators from selected veterinary schools in the Philippines. This pattern is consistent with Philippine student evidence showing moderate to high biosafety-related knowledge in health-related programs, particularly for hand hygiene, PPE, infection control, and standard precautions [9]–[12]. The findings should be interpreted carefully because the knowledge/familiarity domain measured self-reported familiarity rather than objective test-based knowledge or observed procedural competence [20], [21]. The high familiarity scores may indicate broad awareness of basic biosafety procedures, but they do not establish mastery of applied veterinary biosafety tasks, as shown in Table 3.

Practice/readiness was the weakest KAP domain, especially among students. Although 64.31% of respondents exceeded the >3.67 theoretical high cutoff for practice/readiness, this cutoff represents the upper third of the possible scale range. It should not be equated with consistent or excellent compliance [22]. The item-level results showed weaker areas in hazardous-material handling skills, spill or exposure preparedness, confidence in applying biosafety levels and precautions, and institutional resource adequacy (Table 2). These areas are practical and procedural rather than purely cognitive, which supports the interpretation that biosafety education should move beyond familiarity with rules toward repeated application and supervised performance [3], [6].

The persistence of weaker practice/readiness despite high familiarity suggests that biosafety compliance is shaped by more than knowledge. Students may recognize correct biosafety procedures but still lack repeated supervised practice, confidence in hazardous-material handling, spill-response experience, or immediate access to PPE and disinfectants [3], [6]. Philippine student studies also show that knowledge does not consistently translate into practice, including standard-precaution and infection-control studies where knowledge-practice relationships were weak or nonsignificant [10]–[12]. This pattern supports a competency-based interpretation of biosafety training, in which performance depends on procedural repetition, feedback, and institutional reinforcement rather than on awareness alone [4], [6].

The workflow-barrier item provides a behavioral explanation for the familiarity-practice/readiness gap. Half of the respondents agreed or strongly agreed, in the original response direction, that biosafety protocols sometimes interfere with veterinary work efficiency. This perception matters because behavioral theory distinguishes between knowledge and attitudes and perceived control, feasibility, and contextual barriers that may affect reported practice [7]. In high-workload laboratory, clinical, or animal-handling settings, biosafety procedures may be followed inconsistently when students perceive them as time-consuming or difficult to integrate into routine tasks [4], [6].

Institutional factors may also explain why practice/readiness was lower than familiarity and attitudes. Philippine biosafety and veterinary laboratory evidence points to sparse biosafety documentation, weak protocol implementation, infrastructure limitations, training gaps, and incomplete biorisk governance systems [14]–[16]. These structural conditions can limit students' readiness even when they value biosafety and understand basic procedures [3], [6]. Adequate PPE, disinfectants, spill kits, signage, waste systems, incident-reporting pathways, and trained safety focal persons are institutional prerequisites for consistent biosafety implementation [1]–[3].

The faculty/educator subgroup showed higher KAP scores than students, but this comparison should remain exploratory. The subgroup was small and differed from the student group in age, professional role, teaching experience, and expected biosafety exposure. Higher scores among educators are plausible because professional experience may increase familiarity with laboratory and clinical safety routines, but the present design cannot separate role, experience, selection, or institutional effects [17], [23]. A larger faculty sample would be needed to assess educator-level biosafety competence and training needs with greater precision.

Year level was positively associated with students' familiarity with biosafety, but the magnitude was small. This association may reflect gradual exposure to laboratory, clinical, animal-handling, and public-health activities as students progress through the veterinary curriculum [8]. The small coefficient and low explanatory power of the knowledge/familiarity model suggest that year level alone may not provide a strong progressive biosafety learning pathway (Table 4). Curriculum mapping is needed to determine whether biosafety competencies are introduced, practiced, assessed, and reinforced across preclinical, clinical, farm, diagnostic, and necropsy learning experiences [3], [6], [8].

Knowledge/familiarity was positively associated with attitude, and both familiarity and attitude were positively associated with practice/readiness. These findings are consistent with KAP logic and behavioral theory, where awareness and beliefs may relate to reported safety behavior [4], [7]. However, the cross-sectional design does not support causal interpretation, and students who already perceive themselves as more prepared may also rate their familiarity and attitudes more favorably [17], [24]. Longitudinal or intervention studies are needed to determine whether improving familiarity and attitudes produces measurable changes in observed biosafety behavior [6], [25].

The practice/readiness scale requires cautious interpretation because it combines reported behavior, feasibility, perceived capability, emergency preparedness, and institutional resource adequacy. The reduced behavioral/implementation sensitivity analysis supported the direction of the main model, but the reduced score still contained readiness and implementation-support items rather than purely observed behaviors. The questionnaire underwent face and content validation by three veterinary experts and achieved a CVI of 1.00, supporting item content relevance and appropriateness within the intended veterinary biosafety context. However, exploratory or confirmatory factor analyses were not conducted, and internal consistency does not independently establish dimensional validity [20], [21]. The three domains should be interpreted according to their operational definitions rather than as fully established latent psychometric constructs. Future instruments should separate objective knowledge, attitudes, self-efficacy, institutional resources, emergency preparedness, and observed practice into distinct subdomains and evaluate their structural properties.

The findings have direct implications for veterinary education. Biosafety instruction should not rely solely on lectures, written policies, or early orientation, as practice gaps may persist despite strong familiarity [6], [10]. Veterinary programs should include repeated PPE donning and doffing exercises, sharps-safety drills, spill-response simulations, hazardous-material handling practice, clinical and farm biosafety scenarios, and incident-reporting exercises [1]–[3]. These activities should be reinforced across year levels so that biosafety becomes a practiced professional routine rather than a one-time compliance topic [6], [8].

Institution-level biosafety systems are also needed to support student readiness. Veterinary schools should ensure adequate PPE and disinfectant supplies, accessible spill kits, visible biosafety signage, functional waste-disposal systems, updated standard operating procedures, and routine laboratory or clinical biosafety audits [1]–[3]. Institutional biosafety committees or designated safety focal persons can help maintain training records, review incidents, monitor compliance, and align school procedures with national and international biosafety expectations [3], [14]. These systems are important in resource-variable settings where individual motivation may not be enough to sustain safe practice [14]–[16].

The findings may also be relevant to veterinary biosafety education in resource-limited and developing-country settings, although the present nonprobability sample does not support direct generalization to international settings. The combination of high self-reported familiarity and favorable attitudes with weaker practice/readiness suggests an implementation gap that may arise when theoretical instruction is not matched by repeated supervised skills rehearsal, emergency-response experience, reliable access to PPE and disinfectants, or institutional biosafety systems [3], [6], [14]. In such settings, biosafety capacity building may benefit from combining curricular instruction with minimal implementation support, supervised competency assessment, and institutional monitoring, rather than relying primarily on awareness-based training. This context-specific interpretation should be examined in comparable veterinary education systems using locally validated instruments and direct practice measures.

The findings also have policy relevance for Philippine veterinary education and may support regional capacity building. A longitudinal biosafety competency framework could specify what learners should know, demonstrate, and repeatedly practice across preclinical, laboratory, clinical, farm, field, diagnostic, necropsy, and public-health training [6], [8], [14]. Curriculum and quality-assurance systems may benefit from documented practical assessment of PPE use, sharps safety, spill and exposure response, biological-material handling, waste management, and incident reporting, together with periodic refresher training and simulation-based drills. Institutional resource-readiness checks, designated biosafety committees or safety focal persons, and routine school-level implementation monitoring could strengthen continuity between curriculum and practice [3], [14]. Regional initiatives could further support schools with limited infrastructure or specialized biosafety personnel by sharing training resources, standardizing practical competency checklists, and coordinating professional development.

Several limitations should guide interpretation. The nonprobability sample was drawn from selected schools, with heavy representation from Luzon and concentration in several institutions, which limits generalizability [17]. The faculty/educator subgroup was small, making comparisons with students exploratory rather than definitive. The instrument focused mainly on laboratory biosafety and did not comprehensively assess animal restraint, zoonotic transmission routes, necropsy procedures, farm and field biosecurity, clinical waste segregation, or school-level infrastructure indicators [3], [5], [8]. These coverage limitations mean that the findings describe the operational domains measured in this survey rather than the full spectrum of veterinary biosafety competence.

Measurement limitations should also be considered. The questionnaire was developed from established literature and guidance and underwent face and content validation by three veterinary experts, yielding a CVI of 1.00; however, exploratory and confirmatory factor analyses were not conducted, so structural or dimensional validity of the three-domain configuration was not independently established [20]. Knowledge/familiarity items used self-rated familiarity and included procedural statements that may have measured recognition rather than applied understanding [20], [21]. The attitude domain included confidence and self-efficacy items, while the practice/readiness domain combined reported behavior, feasibility, capability, preparedness, and resource adequacy [7], [20]. The domains should be interpreted according to the operational definitions used in this study rather than as fully established latent psychometric constructs. Self-reported responses also overestimate safe practice because social desirability and recall bias can affect questionnaire-based safety research [24], [25]. Future research should use formally validated multidimensional instruments, scenario-based knowledge tests, direct observation of PPE use and hazardous-material handling, longitudinal follow-up, and school-level biosafety audits to evaluate actual competence and institutional readiness [1]–[3], [6]. Veterinary studies further support direct observation and intervention-based evaluation because observed hand hygiene, sharps-handling, infection-control, and biosecurity practices may differ from self-reported readiness, while targeted education can improve selected safety behaviors [26]–[31].

4. CONCLUSION

Multi-school evidence from selected Philippine veterinary schools showed strong self-reported familiarity with biosafety and favorable attitudes among veterinary students and educators, but practice/readiness were comparatively weaker and more variable, particularly among students. The familiarity-attitude-practice/readiness pattern indicates that biosafety education should not rely only on

theoretical instruction, because hazardous-material handling, spill or exposure preparedness, and institutional resource adequacy require repeated supervised application. Veterinary programs should strengthen competency-based biosafety training through PPE drills, sharps-safety exercises, spill-response simulations, hazardous-material handling practice, incident-reporting activities, adequate PPE and disinfection resources, and routine institution-level biosafety audits. Future studies should use longitudinal designs, scenario-based knowledge tests, direct observation of biosafety behavior, and school-level infrastructure assessments to determine whether educational and institutional interventions improve actual biosafety compliance beyond self-reported readiness.

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AUTHOR CONTRIBUTIONS STATEMENT

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C : **C**onceptualization
M : **M**ethodology
So : **So**ftware
Va : **Va**lidation
Fo : **Fo**rmal analysis
I : **I**nvestigation
R : **R**esources
D : **D**ata Curation
O : Writing - **O**riginal Draft
E : Writing - Review & **E**diting
Vi : **Vi**sualization
Su : **Su**pervision
P : **P**roject administration
Fu : **Fu**nding acquisition

CONFLICT OF INTEREST STATEMENT

The authors declare no conflict of interest.

INFORMED CONSENT

All respondents provided informed consent electronically before answering the questionnaire. Participation was voluntary, and responses were handled confidentially for research purposes.

ETHICAL APPROVAL

The study was approved by the Cebu Technological University - Daan Bantayan Local Research Ethics Committee (LREC) on February 15, 2025, with approval code CTU-DB 25-013.

DATA AVAILABILITY

The data that support the findings of this study are available from the corresponding author, [APY], upon reasonable request.

REFERENCES

[1] P. J. Meechan and J. Potts, *Biosafety in microbiological and biomedical laboratories*, 6th ed. Washington, DC: Centers for Disease Control and Prevention, National Institutes of Health, 2020.

[2] World Health Organization, *Laboratory biosafety manual*, 4th ed. Geneva: World Health Organization, 2020.

[3] World Organisation for Animal Health, "Biosafety and biosecurity: standard for managing biological risk in the veterinary laboratory and animal facilities," in *Manual of Diagnostic Tests and Vaccines for Terrestrial Animals*, 13th ed., WOAH, Ed., Paris: World Organisation for Animal Health, 2018.

[4] N. S. Nyokabi *et al.*, "Exploring veterinary students' awareness and perception of zoonoses risks, infection control practices, and biosecurity measures in Ethiopia," *Frontiers in Veterinary Science*, vol. 11, Jul. 2024, doi: 10.3389/fvets.2024.1385849.

[5] A. Sánchez *et al.*, "Zoonoses in veterinary students: a systematic review of the literature," *PLoS ONE*, vol. 12, no. 1, p. e0169534, Jan. 2017, doi: 10.1371/journal.pone.0169534.

[6] J. J. Byrd, E. Emmert, R. Maxwell, and H. Townsend, "Guidelines for biosafety in teaching laboratories version 2.0: a revised and updated manual for 2019," *Journal of Microbiology & Biology Education*, vol. 20, no. 3, 2019, doi: 10.1128/jmbe.v20i3.1975.

[7] I. Ajzen, "The theory of planned behavior," *Organizational Behavior and Human Decision Processes*, vol. 50, no. 2, pp. 179–211, Dec. 1991, doi: 10.1016/0749-5978(91)90020-T.

[8] Commission on Higher Education, *Policies, standards and guidelines for the doctor of veterinary medicine (DVM) program*, CHED Memorandum Order No. 1, s. 2018, 2018. [Online]. Available: https://legacy.ched.gov.ph/wp-content/uploads/2018/02/CMO-1-series-2018-PSG-for-Veterinary-Medicine.pdf

[9] M. B. C. Lao *et al.*, "Adherence to biosafety standard operating procedures – knowledge, attitudes, and practices of medical laboratory science students at an autonomous university in Davao City, Philippines," *Journal of Biosafety and Biosecurity*, vol. 7, no. 4, pp. 151–158, Dec. 2025, doi: 10.1016/j.jobb.2025.10.001.

[10] L. J. Labrague, R. A. Rosales, and M. M. Tizon, "Knowledge and compliance of standard precautions among student nurses," *International Journal of Advanced Nursing Studies*, vol. 1, no. 2, pp. 84–97, Oct. 2012, doi: 10.14419/ijans.v1i2.132.

[11] M. F. L. Tangpuz, L. E. Tapaya, J. L. Dellera, K. D. Geraldo, A. C. Mecaydor, and H. P. Perino, "Knowledge, attitude, and practices on infection control among nursing students in Biliran Province State University," *International Journal For Multidisciplinary Research*, vol. 6, no. 5, pp. 1–15, Oct. 2024, doi: 10.36948/ijfmr.2024.v06i05.29846.

[12] E. Cajurao, "Factors affecting knowledge, attitudes, and practices (KAP) toward COVID-19 pandemic among college students in Masbate, Philippines," *Journal for Educators, Teachers and Trainers*, vol. 14, no. 5, 2023, doi: 10.47750/jett.2023.14.05.031.

[13] R. M. O. Mendoza, D. F. Palacio, and E. B. Calara, "Students' at--risk behavior and safety culture in basic chemistry laboratory," *Journal of BIMP-EAGA Regional Development*, vol. 5, no. 2, pp. 67–75, Dec. 2019, doi: 10.51200/jbimpeagard.v5i2.3270.

[14] R. V. Destura *et al.*, "Assessment of the biosafety and biosecurity landscape in the Philippines and the development of the national biorisk management framework," *Applied Biosafety*, vol. 26, no. 4, pp. 232–244, Dec. 2021, doi: 10.1089/apb.20.0070.

[15] J. J. G. Guerrero and J. E. Serrano, "Biorisk assessment of natural science laboratories of Bicol University College of Science, Philippines," *Human and Ecological Risk Assessment*, vol. 24, no. 1, pp. 57–71, Jan. 2018, doi: 10.1080/10807039.2017.1362951.

[16] J. I. Bibay and J. Agapito, "Survey on health and safety concerns of laboratory animal workers in the Philippines," *Philippine Journal of Science*, vol. 151, no. 2, pp. 605–614, Jan. 2022, doi: 10.56899/151.02.05.

[17] E. V. Elm, D. G. Altman, M. Egger, S. J. Pocock, P. C. Gøtzsche, and J. P. Vandenbroucke, "The strengthening the reporting of observational studies in epidemiology (STROBE) statement: guidelines for reporting observational studies," *PLoS Medicine*, vol. 4, no. 10, pp. 1623–1627, Oct. 2007, doi: 10.1371/journal.pmed.0040296.

[18] S. B. Green, "How many subjects does it take to do a regression analysis," *Multivariate Behavioral Research*, vol. 26, no. 3, pp. 499–510, Jul. 1991, doi: 10.1207/s15327906mbr2603_7.

[19] A. Mutore and M. Barrera, "Institutional Biosafety Committee (IBC)." Accessed: May 1, 2026. [Online]. Available: https://www.utrgv.edu/research/departments/research-integrity/research-compliance/institutional-biosafety-committee-ibc/index.htm

[20] G. O. Boateng, T. B. Neilands, E. A. Frongillo, H. R. Melgar-Quiñonez, and S. L. Young, "Best practices for developing and validating scales for health, social, and behavioral research: a primer," *Frontiers in Public Health*, vol. 6, p. 149, Jun. 2018, doi: 10.3389/fpubh.2018.00149.

[21] M. Tavakol and R. Dennick, "Making sense of Cronbach's alpha," *International Journal of Medical Education*, vol. 2, pp. 53–55, Jun. 2011, doi: 10.5116/ijme.4dfb.8dfd.

[22] C. B. Terwee *et al.*, "Quality criteria were proposed for measurement properties of health status questionnaires," *Journal of Clinical Epidemiology*, vol. 60, no. 1, pp. 34–42, Jan. 2007, doi: 10.1016/j.jclinepi.2006.03.012.

[23] J. G. MacKinnon and H. White, "Some heteroskedasticity-consistent covariance matrix estimators with improved finite sample properties," *Journal of Econometrics*, vol. 29, no. 3, pp. 305–325, Sep. 1985, doi: 10.1016/0304-4076(85)90158-7.

[24] T. van de Mortel, "Faking it: social desirability response bias in self-report research," *Australian Journal of Advanced Nursing*, vol. 25, no. 4, pp. 40–48, Aug. 2008, doi: 10.37464/2008.254.1817.

[25] J. S. Kim and E. Lee, "Difference between self-reported adherence to standard precautions and surveillance and factors influencing observed adherence: a quantile regression approach," *BMC Nursing*, vol. 21, no. 1, p. 199, Dec. 2022, doi: 10.1186/s12912-022-00984-1.

[26] M. E. C. Anderson, J. M. Sargeant, and J. S. Weese, "Video observation of hand hygiene practices during routine companion animal appointments and the effect of a poster intervention on hand hygiene compliance," *BMC Veterinary Research*, vol. 10, no. 1, p. 106, 2014, doi: 10.1186/1746-6148-10-106.

[27] A. Shea and S. Shaw, "Evaluation of an educational campaign to increase hand hygiene at a small animal veterinary teaching hospital," *Journal of the American Veterinary Medical Association*, vol. 240, no. 1, p. 61, 2012, doi: 10.2460/javma.240.1.61.

[28] J. G. Wright, S. Jung, R. C. Holman, N. N. Marano, and J. H. McQuiston, "Infection control practices and zoonotic disease risks among veterinarians in the United States," *Journal of the American Veterinary Medical Association*, vol. 232, no. 12, pp. 1863–1872, Jun. 2008, doi: 10.2460/javma.232.12.1863.

[29] L. Hardefeldt *et al.*, "Veterinary students' knowledge and perceptions about antimicrobial stewardship and biosecurity—a national survey," *Antibiotics*, vol. 7, no. 2, p. 34, Apr. 2018, doi: 10.3390/antibiotics7020034.

[30] I. Agrawal and C. Varga, "Assessing and comparing disease prevention knowledge, attitudes, and practices among veterinarians in Illinois, United States of America," *Preventive Veterinary Medicine*, vol. 228, p. 106223, Jul. 2024, doi: 10.1016/j.prevetmed.2024.106223.

[31] I. Ghali-Mohammed *et al.*, "Risk of zoonotic diseases among veterinary students in Nigeria: a multi-institutional national cross-sectional survey," *Discover Public Health*, vol. 22, no. 1, p. 288, May 2025, doi: 10.1186/s12982-025-00687-3.

APPENDIX

Table 2. Descriptive item-level KAP levels of respondents by domain

Domain	Item focus	Mean±SD	Low n (%)	Moderate n (%)	High n (%)	Descriptive level
Knowledge/ familiarity	Handwashing after hazardous material work and before leaving the laboratory	4.77±0.44	0 (0.00)	2 (0.78)	253 (99.22)	High
	Prohibition of eating, drinking, smoking, contact-lens handling, cosmetics, and food storage in laboratory areas	4.77±0.45	0 (0.00)	3 (1.18)	252 (98.82)	High
	Safe needle and sharps management before disposal	4.73±0.46	0 (0.00)	2 (0.78)	253 (99.22)	High
	Safe handling of broken glassware and substitution of plasticware when possible	4.62±0.51	0 (0.00)	3 (1.18)	252 (98.82)	High
	Biohazard signage, biosafety-level information, supervisor contact details, and entry/exit procedures	4.36±0.80	6 (2.35)	16 (6.27)	233 (91.37)	High
	Integrated pest management program	4.13±0.88	10 (3.92)	23 (9.02)	222 (87.06)	High
	Durable, leak-proof, and secured transport of materials for decontamination outside the immediate laboratory	4.45±0.71	3 (1.18)	15 (5.88)	237 (92.94)	High
	Personnel health status, immune competence, infection susceptibility, and counseling information	4.45±0.75	4 (1.57)	15 (5.88)	236 (92.55)	High
	Work-surface decontamination after work and after spills or splashes of potentially infectious material	4.65±0.55	1 (0.39)	4 (1.57)	250 (98.04)	High
Attitude, beliefs, and confidence	Perceived importance of biosafety protocols for preventing infectious disease spread	4.76±0.66	6 (2.35)	2 (0.78)	247 (96.86)	High
	Perceived need for PPE even when exposure risk appears low	4.39±0.96	16 (6.27)	21 (8.24)	218 (85.49)	High
	Perceived interference of biosafety protocols with veterinary work efficiency, reverse-coded for level classification.	2.66±1.36	128 (50.20)	42 (16.47)	85 (33.33)	Moderate
	Perceived need for investment in biosafety infrastructure	4.71±0.70	6 (2.35)	5 (1.96)	244 (95.69)	High
	Perceived importance of continuing biosafety education for experienced professionals	4.69±0.71	7 (2.75)	4 (1.57)	244 (95.69)	High
	Peer and colleague seriousness as a condition for following protocols	4.46±0.90	12 (4.71)	15 (5.88)	228 (89.41)	High
	Confidence in implementing biosafety protocols in laboratory settings	3.51±0.76	16 (6.27)	109 (42.75)	130 (50.98)	Moderate
	Confidence in identifying biosafety hazards in veterinary environments	3.52±0.84	26 (10.20)	97 (38.04)	132 (51.76)	Moderate
	Confidence in maintaining biosafety records and incident documentation	3.47±0.79	26 (10.20)	100 (39.22)	129 (50.59)	Moderate
	Confidence in understanding and applying biosafety levels and corresponding measures	3.47±0.93	37 (14.51)	83 (32.55)	135 (52.94)	Moderate
	Confidence in responding to spills or exposure incidents using biosafety protocols	3.38±0.84	31 (12.16)	115 (45.10)	109 (42.75)	Moderate
	Preparedness to use PPE correctly in different biosafety situations	3.80±0.95	18 (7.06)	76 (29.80)	161 (63.14)	High
	Belief that strict biosafety adherence reduces disease-transmission risk	4.62±0.59	0 (0.00)	14 (5.49)	241 (94.51)	High
	Expectation that proper PPE use prevents contamination and infectious-agent exposure	4.54±0.66	1 (0.39)	21 (8.24)	233 (91.37)	High
	Belief that accurate biosafety records can prevent future incidents or outbreaks	4.59±0.61	1 (0.39)	14 (5.49)	240 (94.12)	High
	Belief that learning biosafety enhances professional competence and career prospects	4.66±0.59	0 (0.00)	15 (5.88)	240 (94.12)	High
	Perceived effectiveness of strict waste-disposal protocols in preventing environmental contamination	4.68±0.59	1 (0.39)	14 (5.49)	240 (94.12)	High
	Confidence that biosafety guideline compliance prevents legal and regulatory issues	4.47±0.80	7 (2.75)	26 (10.20)	222 (87.06)	High
	Belief that a strong institutional biosafety culture improves the learning and working environment	4.64±0.59	1 (0.39)	12 (4.71)	242 (94.90)	High
	Agreement that biosafety measures protect personal health and safety	4.42±1.24	27 (10.59)	2 (0.78)	226 (88.63)	High

Table 2. Descriptive item-level KAP levels of respondents by domain (*continued*)

Domain	Item focus	Mean±SD	Low n (%)	Moderate n (%)	High n (%)	Descriptive level
Practice/ readiness	Feasibility of consistently following required biosafety protocols during laboratory work	3.88±0.74	5 (1.96)	71 (27.84)	179 (70.20)	High
	Practicality of always wearing PPE in the current environment	3.96±0.85	10 (3.92)	64 (25.10)	181 (70.98)	High
	Practicality of implementing decontamination after handling biological materials	4.37±0.74	2 (0.78)	34 (13.33)	219 (85.88)	High
	Feasibility of participating in emergency drills for spills or exposures	4.03±0.87	13 (5.10)	47 (18.43)	195 (76.47)	High
	Ease of incorporating waste-disposal protocols into daily routines	4.12±0.86	10 (3.92)	51 (20.00)	194 (76.08)	High
	The capability to correctly implement biosafety protocols in daily activities	3.73±0.83	11 (4.31)	95 (37.25)	149 (58.43)	High
	Skills for safely handling potentially hazardous biological materials	3.44±0.86	28 (10.98)	118 (46.27)	109 (42.75)	Moderate
	Perceived availability of PPE, disinfectants, and other resources for biosafety practice	3.76±0.92	21 (8.24)	74 (29.02)	160 (62.75)	High
	Preparedness to respond to spills or accidental exposure	3.54±0.86	24 (9.41)	99 (38.82)	132 (51.76)	Moderate
	Capability to ensure proper waste disposal under biosafety guidelines	3.78±0.89	16 (6.27)	76 (29.80)	163 (63.92)	High
	Confidence in knowledge and application of biosafety levels and precautions	3.49±0.98	32 (12.55)	96 (37.65)	127 (49.80)	Moderate
	The capability to update and adapt biosafety practices as new information becomes available	3.77±0.89	18 (7.06)	77 (30.20)	160 (62.75)	High
	Frequency of PPE use in laboratory or clinical settings	4.13±0.96	19 (7.45)	36 (14.12)	200 (78.43)	High
	Frequency of appropriate PPE use when interacting with potentially hazardous animals	4.40±0.78	5 (1.96)	28 (10.98)	222 (87.06)	High
	Institutional provision of PPE, disinfectants, and resources for biosafety protocols	3.61±1.18	51 (20.00)	56 (21.96)	148 (58.04)	Moderate
	Likelihood of correcting overlooked biosafety practices in the environment	3.94±0.89	14 (5.49)	60 (23.53)	181 (70.98)	High

Item scores: low=1–2; moderate=3; high=4–5. For A03, scores were reverse-coded for level classification so that higher levels indicate a more favorable attitude or lower perceived efficiency barrier; the original response distribution was retained. The descriptive level is based on the item mean, using scale-based cutoffs: low=1.00–2.33, moderate=2.33–3.67, and high=3.67–5.00.

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